Archaeological Prospection

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EDITORIAL

The Future of *Archaeological Prospection*

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ABSTRACT

This editorial marks the transition of editorial leadership at *Archaeological Prospection* and outlines priorities for the journal's next phase. We review the journal's 30-year history and assess opportunities created by the convergence of machine learning, miniaturized sensors and cloud computing. We identify two primary objectives: establishing rigorous standards for reproducibility and open science, and prioritizing submissions that demonstrate how non-invasive methods address substantive archaeological research questions. We introduce revised publication formats and address the need to expand representation beyond the journal's historically European and North American base. These changes position *Archaeological Prospection* as a knowledge transfer platform for 21st-century archaeological practice.

As incoming editors, we would like to express our deepest gratitude to the outgoing editors, Dr. Eileen Ernenwein and Professor Gregory Tsokas. Over the past six and a half years, their efforts have furthered the remarkable tradition of publishing innovative methodological approaches to the study of the archaeological record. With over 760 publications, 13 000+ citations and a 2024 impact factor of 1.9, the journal remains the premier venue for methodological innovation in non-invasive archaeological investigation, bridging traditional field archaeology with cutting-edge computational approaches from geophysics, remote sensing and computer science.

Since its inception in 1994, *Archaeological Prospection* has evolved into a truly interdisciplinary forum that aims to produce knowledge broadly applicable not only to archaeologists but also to disciplines and industries across environmental science, heritage management and resource planning. The journal has documented the transformation of the field of archaeological geophysics through four distinct technological phases: digital geophysics (1994–2005), 3D visualization and multi-sensor integration (2006–2015), automated analysis and UAV platforms (2016–2020), and AI-powered landscape archaeology (2021-present). Foundational papers include Becker's (1995) introduction of picotesla magnetometry, enabling detection of extremely weak magnetic signatures; Goodman et al.'s (1995) GPR time-slice methodology that revolutionized ground-penetrating radar visualization; Verhoeven's (2011) structure-from-motion photogrammetry democratizing 3D documentation; Hesse's (2010) local relief model for LiDAR visualization; and Trier et al.'s (2019) application of deep neural networks to automated feature detection.

Recent volumes showcase the convergence of machine learning, drone-based sensing and multi-sensor data fusion, with papers demonstrating that CNN models achieve 80% accuracy in site detection, UAV-mounted magnetometers map inaccessible terrain, and automated processing workflows handle terabyte-scale datasets. Special issues have established best practices for challenging environments, such as Mediterranean forests. Meanwhile, ethical considerations regarding Indigenous communities (e.g., Davis et al. 2021; Davis and Sanger 2021; Sturm and Herrmann 2024; Wadsworth et al. 2024; Whiting 2024) and scientific rigour have emerged as critical concerns, exemplified by the 2024 retraction of the Gunung Padang paper (Editors 2024).

The last 5 years (2020–2025) of technological development suggest that *Archaeological Prospection* stands at an extraordinary

inflection point, where converging technologies create unprecedented opportunities to understand the archaeological record at scales previously unimaginable. Machine learning algorithms now process terabyte-scale datasets in hours rather than years, with deep neural networks detecting subtle archaeological signatures (e.g., Verschoof-van der Vaart and Lambers 2022). Miniaturized sensors deployed on drones (e.g., Risbøl and Gustavsen 2018; Stele et al. 2022), autonomous surface vessels (e.g., Beltrame et al. 2025; Olsen et al. 2025) and even satellite constellations (e.g., Linck et al. 2013; McGrath et al. 2023) access environments from dense forest canopies (e.g., Cirigliano et al. 2025) to ocean floors (e.g., van den Brenk et al. 2025), whereas multi-sensor fusion reveals archaeological features invisible to single detection methods (e.g., Karamitrou et al. 2020).

The integration of magnetometry, GPR, LiDAR, hyperspectral and thermal data through neural network architectures enables the identification of complex relationships between soil chemistry, vegetation patterns and buried structures that human analysts could never manually synthesize. Cloud computing and open-source frameworks democratize these capabilities, enabling small research teams to apply sophisticated deep learning models, automated feature extraction and pattern recognition across entire landscapes. Real-time processing enables field archaeologists to adjust survey strategies as AI identifies anomalies. Transfer learning allows models trained on well-studied regions to detect similar features in previously unexplored areas. This technological convergence transforms archaeological prospection from sampling limited areas to comprehensive landscape-scale investigation, where AI-assisted analysis reveals not just individual sites but entire settlement systems, agricultural patterns and environmental relationships across millennia of human occupation (e.g., Arnoldussen et al. 2023; Davis et al. 2021; der Vaart et al. 2023). Most recently, researchers have leveraged generative AI models to assist in analysing geophysical data (e.g., Zakirov et al. 2025).

This remarkable trajectory brings both extraordinary opportunities and fundamental responsibilities for the journal's next phase. *Archaeological Prospection* stands uniquely positioned to catalyse and guide this technological transformation, serving not merely as a publication venue but as an active architect of the discipline's future. To achieve this, several initiatives need to take place:

1. The journal must champion rigorous standards of reproducibility that extend beyond traditional peer review to embrace the principles of open science articulated by Marwick et al. (2017)—requiring authors to provide complete documentation of field procedures, processing workflows, algorithmic parameters and annotated code repositories. This transparency serves dual purposes: ensuring scientific validity through replication while providing detailed roadmaps for practitioners seeking to adapt these approaches to new archaeological contexts and research questions.
2. More fundamentally, the journal must demonstrate that geophysical prospection and remote sensing are not merely auxiliary technical services but integral components of archaeological inquiry that directly address substantive research questions about past human behaviour, social organization and environmental interactions. Although technical reports documenting methodological innovations remain essential, we have an unprecedented opportunity to establish new standards for conservation-minded archaeological practice that maximizes knowledge production while minimizing site disturbance. Papers should explicitly articulate how non-invasive methods answer archaeological questions that excavation alone cannot address—from landscape-scale settlement patterns to temporal dynamics visible only through multi-sensor integration.

By fostering a collaborative community where code sharing, dataset publication and methodological transparency are normalized rather than exceptional, *Archaeological Prospection* can ensure that advances in one region or application domain rapidly propagate throughout the global archaeological community. This approach positions the journal to define best practices for 21st-century archaeology: achieving maximum spatial coverage at minimum cost with zero impact on the archaeological record while producing replicable, verifiable knowledge that advances our understanding of human history across all scales of analysis. The journal's revised author guidelines stress this methodological rigour.

In assuming the role of leading *Archaeological Prospection*, it is essential that the journal not only promotes methodological development but also contributes to the broader archaeological and geophysical communities through theoretical and empirical advancements in science. An editorial published nearly 17 years ago suggested the following:

> Although there are always technical advances to be made, and methods to be perfected, we feel that many of the future publications will concentrate on using these tools for innovative hypothesis testing of ideas about the past. Prospection alone need not be the ultimate goal, as today this is often the more mundane and simple part of any project that uses these methods … Although locating buried cultural remains is always exciting and can add much to research plans that could involve excavation or preservation, even more exciting is the use of those results to help explain aspects of ancient cultures that can be known in no other way.
>
> (Aspinall et al. 2008, 245)

The situation remains eerily similar to that of the journal almost two decades ago. Although numerous studies published in *Archaeological Prospection* since that time have achieved this goal, many articles continue to serve primarily as method or site reports. Moving forward, we intend to steer submissions and the journal's future towards richer scientific applications of geophysical technologies while maintaining the methodological rigour that has long served the journal well. This is required to ensure that *Archaeological Prospection* increases its impact on archaeological science and attracts new readers worldwide.

Moreover, the journal's international reputation is showcased not merely by its impact factor and ranking metrics, but by the diversity of countries from which submissions originate. In 2025 alone, the journal received 118 submissions from 40 countries across six continents (Figure 1).

The journal is not merely of intellectual interest; it has a mission to inform a variety of stakeholders, industries and practitioners about the best practices and applications of geophysical technologies for studying the near-surface environment. To this end, articles must be transparent, methodologically reproducible and accessible to a broad audience, including academics, policymakers and industry stakeholders.

The development of rigorous standards and comprehensive data sharing becomes even more critical in the era of machine learning, where collective progress depends on our ability to aggregate training datasets across projects, regions and sensor types. As we build shared repositories of annotated geophysical data, we enable algorithms to learn from thousands of surveys rather than dozens, transforming idiosyncratic site-specific studies into cumulative knowledge that advances the entire discipline. This is particularly crucial for methods like GPR interpretation, which have remained largely an art form dependent on individual expertise—but with sufficient standardized training data, machine learning models could capture and systematize the pattern recognition skills of expert interpreters, making this knowledge transferable across practitioners and contexts (e.g., Küçükdemirci and Sarris 2020).

During our tenure, we aim to prioritize scientific reproducibility and transparency across all the journal's publications, recognizing that these principles are foundational to realizing the transformative potential of AI-assisted prospection. Too often, methodological articles fail to share their approaches in transparent, reproducible ways, as documented by Marwick et al. (2017) in their critiques of computational archaeology. As a methods-oriented journal, *Archaeological Prospection* has a responsibility to ensure reproducibility, and we aim to improve this going forward. Indeed, the discipline's progress is tied to our community's ability to share and learn from innovations. New advances in deep learning and AI highlight the need for careful documentation of methods and the ability to reproduce research findings, given that trained models, annotated datasets and processing code are involved. Without access to these essential components, breakthrough methods remain locked within individual research groups rather than catalysing field-wide advancement.

Moving forward, all articles accepted for publication in *Archaeological Prospection* will be required to meet standards of reproducibility and transparency. Namely, all articles must

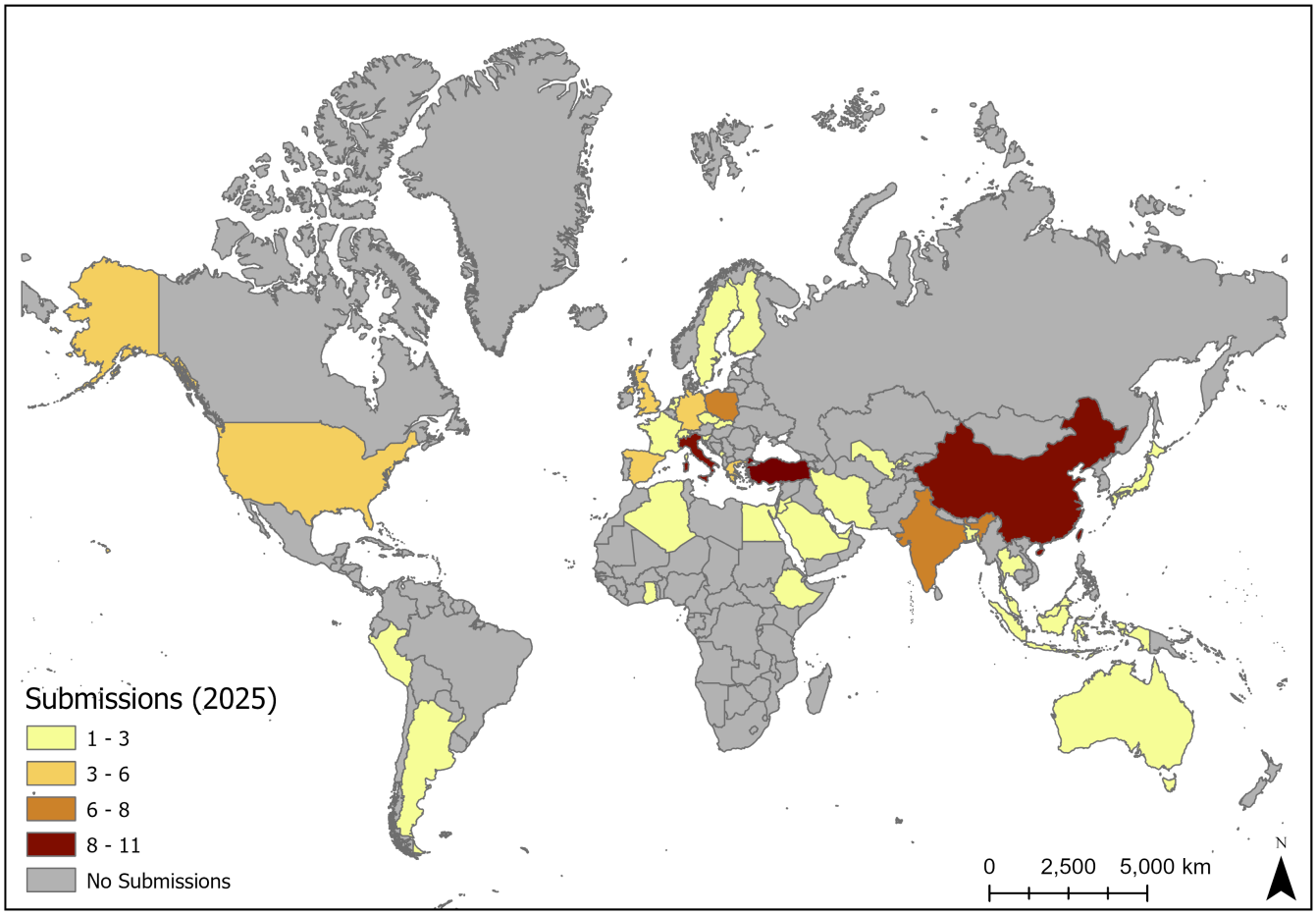

FIGURE 1 | The total number of submissions by country of the corresponding author in 2025. Although Europe remains a dominant source of the journal's literature, researchers from China submitted the most, followed by Italy and Turkey.

include the means to reproduce the methods and approaches discussed in publications—including source code with documentation, trained models with architecture specifications, processing parameters, annotated training datasets where feasible and detailed workflows that enable replication. Although we strongly encourage the use of open-source software to maximize accessibility, we recognize that commercial packages remain necessary for many practitioners. In such cases, authors must provide comprehensive documentation of all processing steps, parameter settings and analytical decisions, enabling readers to reproduce the workflow in alternative software environments or verify the results independently.

For geophysical surveys, this means publishing raw data alongside processed results, documenting instrument settings and field conditions and providing the complete processing chain from acquisition to interpretation. Authors must specify the data repository locations where their datasets and code will be permanently archived. The journal encourages researchers to use established repositories, such as *Zenodo* and the Open Science Framework, as well as discipline-specific archives, to ensure long-term accessibility. Not only is this necessary for producing good, practical scientific work, but it is also imperative to accomplish the journal's mission of informing archaeologists, environmental scientists, site developers, local authorities and regional environmental agencies about the scientific techniques available for studying the near-surface environment. These new standards and publication formats will be phased in over the coming year, with complete implementation expected by December 2026.

The central objective of these changes is to ensure that *Archaeological Prospectio*n remains the definitive resource for practitioners seeking to understand and implement cutting-edge prospection technologies. The discipline has evolved far beyond the straightforward application of individual sensors to encompass complex workflows that integrate multiple data streams, sophisticated processing algorithms and interpretative frameworks that synthesize geophysical, geochemical and remote-sensing datasets. This complexity makes comprehensive methodological documentation not merely desirable but essential. Practitioners can adopt and adapt innovations only when they have access to complete technical specifications, processing parameters, computational workflows and decision-making criteria that produced the published results. The era when a brief methods section could adequately describe magnetometer survey parameters has given way to multi-sensor fusion, which requires documenting registration algorithms, normalization procedures, weighting schemes and interpretive thresholds across heterogeneous datasets. By enforcing rigorous documentation standards, we ensure that every published study serves as both a scientific contribution and a practical tutorial, enabling researchers worldwide to implement these methods regardless of their institutional resources or geographic location. This transformation from publication venue to knowledge transfer platform represents a fundamental shift in how archaeological prospection advances as a discipline. Rather than innovations remaining siloed within individual research groups or being accessible only through expensive training workshops, the journal can serve as the primary mechanism for propagating methodological expertise across the global archaeological community. Achieving this vision requires an unprecedented commitment to transparency from authors and reviewers alike; the result will be a journal that not only documents innovation but also actively accelerates its adoption and refinement across diverse archaeological contexts.

The integration of artificial intelligence into archaeological prospection workflows demands particular attention to transparency and validation protocols. Although machine learning algorithms demonstrate remarkable capabilities in automated feature detection, pattern recognition across multisensor datasets and landscape-scale archaeological analysis, their implementation requires rigorous documentation standards beyond traditional methodological reporting. Authors using AI methods must provide full transparency into training datasets, model architectures, hyperparameters, validation procedures and performance metrics. All code must be accessible through permanent repositories, accompanied by clear documentation of dependencies and computational requirements. For proprietary AI systems or commercial machine learning platforms, authors must justify their use and provide comprehensive documentation enabling independent verification of processing steps and analytical decisions. The journal acknowledges AI's legitimate role in assisting non-native English speakers with manuscript preparation, provided such assistance is explicitly acknowledged in the acknowledgments. However, all AI-generated or AI-assisted content requires careful human validation, particularly regarding citations, technical specifications and archaeological interpretations. The presence of hallucinated references, fabricated data or unverified technical claims constitutes a fundamental breach of scientific integrity that will result in immediate manuscript rejection. These requirements naturally follow from our commitment to open science principles, ensuring that AI enhances, rather than compromises, the reproducibility, transparency and reliability that define rigorous archaeological prospection research.

One additional area that demands transformation in the years ahead is the fundamental expansion of representation among the journal's authors, publications and readership, beyond its historically European and North American core. The stark disparities between the Global North and Global South in access to advanced geophysical technologies and computational methods—particularly machine learning and automated processing—create a self-reinforcing cycle in which innovations developed for well-resourced contexts fail to address the realities faced by most of the world's archaeologists (Davis 2020). Yet, vibrant geophysical research thrives across Asia, Africa, Latin America and the Pacific, often developing innovative low-cost solutions and methodological adaptations that could benefit the entire discipline if given appropriate platforms for dissemination. For example, recent work using low-cost magnetometers has demonstrated detection capabilities with sufficient sensitivity under certain conditions, comparable to traditional gradiometers at a fraction of the cost (Accomando and Florio 2024). Meanwhile, community-based UAV mapping projects in Alaska have developed protocols for training local stakeholders to ensure sustainable, locally managed heritage documentation (Lim et al. 2022). A current special issue of ARP explores remote sensing archaeology in South America, exemplifying this untapped potential and revealing sophisticated applications of prospecting

methods in challenging environments that push technological boundaries in ways that well-funded European projects rarely need to consider.

To expand accessibility and broaden participation in archaeological prospection, we will begin to utilize Short Reports more fully as a publication category alongside our traditional Research Articles. Research Articles remain the venue for hypothesis-driven investigations that advance archaeological prospection through methodological innovation and theoretical contributions. These papers require explicit research questions, a comprehensive literature review, rigorous testing protocols and a discussion of broader implications for prospection practice and archaeological interpretation. Short Reports document applications of geophysical prospection and remote sensing methods through structured descriptions of fieldwork, analytical procedures and results. This format serves practitioners conducting field investigations who produce valuable technical data but may lack the theoretical framework or extended datasets required for hypothesis-driven research articles. The standardized format will include mandatory sections on data acquisition parameters, processing workflows, visualization methods and data availability, ensuring reproducibility and supporting open science principles (Marwick et al. 2017; see the revised author guidelines for more details). By establishing clear documentation standards for instrument settings, survey configurations, environmental conditions and analytical procedures, we aim to use **Short Reports** to create a repository of methodological knowledge accessible to researchers across diverse archaeological and environmental contexts. This publication pathway acknowledges that systematic documentation of prospecting applications provides essential empirical foundations for the discipline, particularly for scholars with limited resources, those addressing conservation threats or those operating in regions where prospecting methods require local adaptation.

Following successful models from journals like *The Journal of Island and Coastal Archaeology*, these formats particularly benefit early-career researchers and graduate students from underrepresented regions, providing critical experience with international peer review while building global professional networks. By explicitly valuing methodological creativity born from necessity alongside expensive high-tech solutions, *Archaeological Prospection* can catalyse truly global advancement where innovations from the periphery inform and improve practice at the centre, ultimately strengthening the discipline's capacity to document and protect cultural heritage worldwide.

Going beyond traditional academic boundaries, *Archaeological Prospection* must serve as a bridge between cutting-edge methodological development and practical implementation across diverse global contexts. The profound disparities in access to advanced technologies—where a single GPR unit may cost more than an entire archaeological project budget in many countries—and the prohibitively expensive cloud computing for AI processing, which remains out of reach for most institutions, create a fragmented discipline where methodological advances benefit only well-resourced practitioners (Davis 2020). Yet these constraints often drive remarkable innovation: magnetometry surveys using smartphones in India, community-based drone mapping in Peru and crowd-sourced image analysis in sub-Saharan Africa demonstrate that necessity generates solutions with global applicability. As editors, we recognize that genuine disciplinary advancement necessitates dismantling the assumption that technological sophistication flows unidirectionally from wealthy institutions to resource-constrained contexts.

To achieve genuine global reach, the journal must actively facilitate knowledge exchange through multiple mechanisms beyond traditional article publication. This includes publishing workflows optimized for limited computational resources, documenting open-source alternatives to expensive proprietary software and highlighting successful applications using older-generation equipment that remain the reality for most practitioners worldwide. We will prioritize articles that demonstrate scalability and adaptability—showing how methods developed for one context can be modified for different archaeological, environmental and economic realities. Industry partnerships must extend beyond equipment manufacturers to include local CRM firms, government heritage agencies and NGOs, which often conduct most prospecting work outside academic settings. By establishing regional editorial advisors, we hope to encourage submissions from underrepresented regions. In this way, *Archaeological Prospection* can transform from a venue that documents technological advances to a catalyst that ensures these advances meaningfully improve archaeological practice wherever cultural heritage requires investigation and protection.

Archaeological Prospection has a rich history and a strong international reputation. Our goal is to strengthen it in the years to come. To conclude, we want to return to some words of former editors of this journal:

> The future of the journal is, obviously, critically dependent on continued active interest internationally in our discipline and the responsible publication of researchers' findings from a wide variety of sites worldwide.
>
> (Aspinall et al. 2008, 245)

Today, *Archaeological Prospection* stands at a threshold where technological capabilities finally match archaeological ambitions. The convergence of AI, miniaturized sensors and global connectivity creates unprecedented potential to understand human history on a planetary scale while preserving the physical record for future generations. *Archaeological Prospection* will not merely document this transformation but actively shape it, ensuring that methodological innovation serves archaeological knowledge, that technological advancement includes all practitioners, and that our collective efforts build a truly global understanding of the human past.

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Data Availability Statement

Data sharing is not applicable to this article as no datasets were generated or analysed during the current study.

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